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Original Research Article

Serial SOFA Outperforms APACHE II in Predicting 30-Day Mortality among Patients with Sepsis and Multi-Organ Dysfunction Syndrome: A Prospective Observational Study

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ABSTRACT

Background: One of the leading causes of death among critically ill patients is still sepsis with multi-organ dysfunction syndrome (MODS). Optimising intensive care management and resource allocation requires early identification of high-risk patients. The relative efficacy of APACHE II and Sequential Organ Failure Assessment (SOFA) scores in predicting mortality in patients with sepsis and MODS remains debatable, despite their widespread usage as prognostic tools. This study compared the predictive accuracy of APACHE II and SOFA scores in determining 30-day mortality.

Methods: From February 2024 and August 2025, a prospective observational study was carried out in the Department of Anaesthesiology at MKCG Medical College in Berhampur. A total of sixty adult patients (≥18 years old) with MODS and sepsis were included. (While SOFA scores were evaluated on Days 1 and 3, and mean SOFA scores were subsequently determined, APACHE II scores were computed within 24 hours of admission.) APACHE II scores were computed within 24 hours of admission, whereas SOFA scores were evaluated on days 1 and 3 to determine the mean SOFA scores. After a 30-day follow-up, patients were classified as either survivors or non-survivors. SPSS and Epi Info were used for statistical analysis; $p<0.05$ was deemed statistically significant.

Results: Among the 60 patients studied, 22 died, yielding a 30-day mortality rate of 36.7%. Non-survivors had significantly higher APACHE II scores than survivors (25.63±5.78 vs. 16.81±4.52; $p<0.05$). Similarly, SOFA scores were markedly elevated among non-survivors: Day-1 SOFA (10.68±1.86 vs. 5.18±1.90), Day-3 SOFA (12.09±1.62 vs. 5.44±1.99), and mean SOFA (11.38±1.66 vs. 5.63±1.90) (all $p<0.05$). Serial SOFA assessment demonstrated superior prognostic utility, with rising Day-3 SOFA scores being strongly associated with mortality. Increased heart rate, respiratory rate, serum sodium, serum creatinine, and serum bilirubin levels, along with lower Glasgow Coma Scale scores, were independently associated with mortality ($p<0.05$).

Conclusion: Both APACHE II and SOFA scores are significant predictors of 30-day mortality in patients with sepsis and MODS. However, serial SOFA monitoring, particularly the Day-3 SOFA assessment, provides superior prognostic information compared to a single APACHE II measurement. Incorporating serial SOFA evaluation into routine critical care practice may improve risk stratification and clinical decision-making.

Keywords: Sepsis, Multi-Organ Dysfunction Syndrome, APACHE II, SOFA Score, Mortality Prediction, Critical Care, Prognosis.

INTRODUCTION

Despite improvements in critical care therapy, sepsis-a potentially fatal clinical condition marked by organ failure brought on by a dysregulated host response to infection-

remains one of the principal causes of morbidity and mortality globally.[1] The global burden of sepsis continues to be substantial, accounting for millions of deaths annually andposing a significant challenge to healthcare systems, particularly in developing countries.[2]

The progression of sepsis to Multi-Organ Dysfunction Syndrome (MODS) represents a severe stage of the disease continuum and is associated with markedly increased mortality. The pathophysiology of MODS involves a complex interplay of inflammatory mediators, endothelial dysfunction, microcirculatory impairment, coagulation abnormalities, and cellular metabolic derangements, ultimately leading to failure of multiple organ systems.[3] Mortality rates in patients with sepsis-associated MODS range from 30% to 60%, depending on the severity of illness and the extent of organ dysfunction.[2,3]

(For prompt therapeutic intervention, efficient use of intensive care resources, and enhancement of clinical outcomes, early identification of patients at high risk of deterioration is crucial.) Early identification of patients at high risk of deterioration is crucial for prompt therapeutic intervention, efficient allocation of intensive care resources, and the improvement of clinical outcomes. For critically ill patients, a number of grading systems have been developed to provide objective assessment of illness severity and prognosis. The most popular and reliable prognostic instruments are the Sequential Organ Failure Assessment (SOFA) score and the Acute Physiology and Chronic Health Evaluation II (APACHE II) score.[4,5]

The APACHE II scoring system, developed by Knaus et al., incorporates acute physiological variables, age, and chronic health status to estimate disease severity and predict hospital mortality.[4] Owing to its simplicity and reproducibility, APACHE II has been extensively utilized in intensive care units for risk stratification and outcome prediction in patients with sepsis and other critical illnesses.[6]

(The respiratory, cardiovascular, hepatic, coagulation, renal, and neurological systems are the six main organ systems for which the SOFA score was developed by Vincent et al.[5]) The SOFA score, developed by Vincent et al., evaluates six primary organ systems: respiratory, cardiovascular, hepatic, coagulation, renal, and neurological.[5] Unlike the APACHE II, the SOFA score can be assessed serially, enabling dynamic monitoring of disease progression and response to therapy. Ferreira et al. demonstrated that serial SOFA measurements correlate strongly with patient outcomes and provide valuable prognostic information in critically ill patients.[7]

The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3), which included organ dysfunction measured by the SOFA score in the diagnostic criteria for sepsis, further highlighted the significance of SOFA in sepsis assessment.[1] Consequently, serial evaluation of organ dysfunction has become an integral component of modern sepsis management.

Several studies have compared the predictive performance of APACHE II and SOFA scores in critically ill patients. Qiao et al. reported that the SOFA score demonstrated superior predictive ability compared with APACHE II in elderly critically ill patients.[8] Similarly, Abhinandan and Vedavathi observed that serial SOFA assessment was a more reliable predictor of mortality than a single admission APACHE II score in patients with sepsis-associated MODS.[9] In contrast, Ho et al. found that combining APACHE II with organ dysfunction scores improved mortality prediction, highlighting the continuing debate regarding the optimal prognostic model in critically ill patients.[10]

AIMS AND OBJECTIVES

The present study aimed to evaluate and compare the prognostic accuracy of the Acute Physiology and Chronic Health Evaluation II (APACHE-II) score and the Sequential Organ Failure Assessment (SOFA) score in predicting 30-day mortality among patients presenting with sepsis and multi-organ dysfunction syndrome (MODS). Specifically, the study sought to determine the mortality prediction accuracy of the APACHE-II scoring system, assess the predictive performance of the SOFA scoring system in the same patient population, and compare the effectiveness of both scoring tools to identify the more reliable prognostic indicator for risk stratification and outcome prediction in critically ill patients with sepsis and MODS.

MATERIALS AND METHODS

Study Design

This prospective observational study was conducted over an 18-month period, from

February 2024 to August 2025, in the Department of Anesthesiology at MKCG Medical College in Berhampur. In patients presenting with sepsis and multi-organ dysfunction syndrome (MODS), the study sought to evaluate and compare the mortality prediction accuracy of the Acute Physiology and Chronic Health Evaluation II (APACHE-II) and Sequential Organ Failure Assessment (SOFA) scoring systems. The primary objective was to evaluate and compare the mortality prediction accuracy of the APACHE II and Sequential Organ Failure Assessment (SOFA) scoring systems in patients with sepsis and multi-organ dysfunction syndrome (MODS).Eligible patients were evaluated using both scoring systems upon admission, and their outcomes were subsequently monitored to determine the predictive performance of each score for mortality.

Inclusion and Exclusion Criteria

The study comprised patients who were 18 years of age or older who had been diagnosed with both sepsis and multi-organ dysfunction syndrome (MODS) at the time of admission. To prevent potential confounding factors that could affect disease progression, organ dysfunction, and death outcomes, the study excluded pregnant women, patients receiving immunosuppressive medication, and patients who were known to be HIV positive.

Sample Size

A total of 60 adult patients diagnosed with sepsis and multi-organ dysfunction syndrome were included based on the selection criteria.

Data Collection Procedure

After obtaining informed consent, demographic, clinical, and laboratory data were collected for all enrolled patients. APACHE-II scores were calculated within the first 24 hours of admission using physiological parameters, Glasgow Coma Scale, age, and chronic health status. Organ dysfunction was assessed using SOFA scores recorded on Day 1 and Day 3, with the mean SOFA score calculated when both values were available. Relevant investigations, including hematological, biochemical, microbiological, and radiological tests, were performed as clinically indicated. Patients were followed for 30 days, and outcomes were recorded as survivor or non-survivor for comparison of the predictive accuracy of APACHE-II and SOFA scoring systems.

Statistical Analysis

Statistical analysis was performed using SPSS and Epi Info software. Data were summarized using appropriate descriptive and inferential statistical methods. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Variable	Total (n=60)
Age (years), Mean ± SD	53.8 ± 15.2*
Male	31 (51.7%)
Female	29 (48.3%)
Survivors	38 (63.3%)
Non-survivors	22 (36.7%)

Table 1. Baseline Characteristics and Outcome Distribution

Table 1 illustrates the baseline demographic characteristics and overall mortality outcome of the study population. Among 60 patients with sepsis and MODS, 38 (63.3%) survived while 22 (36.7%) died within 30 days, indicating a substantial mortality burden.

Age Group (Years)	Total	Survivors	Non-survivors	Mortality (%)
20–30	5	2	3	60.0
30–40	12	9	3	25.0
40–50	10	5	5	50.0
50–60	13	8	5	38.5
60–70	13	11	2	15.4
70–80	6	3	3	50.0
>80	1	0	1	100

Table 2. Age-wise Distribution and Mortality

Table 2 shows the age-wise distribution of survivors and non-survivors. Mortality increased at the extremes of age, with the highest mortality observed in patients above 80 years and those aged 70–80 years.

Gender	Total	Survivors	Non-survivors	Mortality (%)
Male	31	22	9	29.0
Female	29	16	13	44.8

Table 3. Gender Distribution and Outcome

Table 3 depicts the relationship between gender and mortality**.** Female patients demonstrated a higher mortality rate (44.8%) compared to male patients (29.0%).

Group	Mean Score	SD	p-value
Survivors	16.81	4.52	
Non-survivors	25.63	5.78	<0.05

Table 4. APACHE-II Score and Mortality

Table 4 compares APACHE-II scores between survivors and non-survivors. Patients who died had significantly higher APACHE-II scores, demonstrating the usefulness of APACHE-II as a predictor of mortality.

SOFA Parameter	Survivors (Mean ± SD)	Non-survivors (Mean ± SD)	p-value
SOFA Day 1	5.18 ± 1.90	10.68 ± 1.86	<0.05
SOFA Day 3	5.44 ± 1.99	12.09 ± 1.62	<0.05
Mean SOFA	5.63 ± 1.90	11.38 ± 1.66	<0.05

Table 5. SOFA Scores and Mortality

Table 5 summarizes the association between SOFA scores and mortality. Day-3 SOFA and mean SOFA scores showed the strongest discrimination between survivors and non-survivors, emphasizing the value of serial SOFA assessment.

Parameter	Survivors Mean ± SD	Non-survivors Mean ± SD	p-value
Rectal Temperature (°C)	38.2 ± 0.69	38.03 ± 0.91	0.21
Heart Rate (/min)	103.6 ± 22.6	124.3 ± 23.2	<0.05
Respiratory Rate (/min)	23.3 ± 7.5	32.7 ± 7.8	<0.05
PaO_2 (mmHg)	69.7 ± 11.26	66.8 ± 11.17	0.17
pH	7.42 ± 0.10	7.38 ± 0.10	0.08
Glasgow Coma Scale	12.9 ± 2.0	9.7 ± 2.3	<0.05

Table 6. Physiological Parameters and Mortality

Table 6 evaluates physiological variables in relation to mortality. Heart rate, respiratory rate, and GCS were significantly associated with mortality, whereas temperature, PaO_2, and pH showed no significant association.

Parameter	Survivors Mean ± SD	Non-survivors Mean ± SD	p-value
Serum Sodium (mEq/L)	142.0 ± 9.73	146.9 ± 7.40	0.02
Serum Potassium (mEq/L)	3.92 ± 0.90	3.63 ± 1.60	0.19
Serum Creatinine (mg/dL)	1.33 ± 0.62	2.50 ± 1.21	<0.05
Serum Bilirubin (mg/dL)	1.40 ± 0.54	4.02 ± 3.30	<0.05
Hematocrit (%)	44.9 ± 7.14	46.2 ± 6.80	0.24
Total Leukocyte Count (/mm^3)	12,944 ± 5,977	11,686 ± 4,909	0.20
Platelet Count (/mm^3)	124,973 ± 67,000	106,700 ± 49,900	0.13

Table 7. Laboratory Parameters and Mortality

Table 7 compares laboratory variables between survivors and non-survivors. Elevated serum sodium, creatinine, and bilirubin levels were significantly associated with mortality, whereas potassium, hematocrit, leukocyte count, and platelet count were not.

Variable	Direction Associated with Mortality	p-value
APACHE-II Score	Higher	<0.05
SOFA Day 1	Higher	<0.05
SOFA Day 3	Higher	<0.05
Mean SOFA	Higher	<0.05
Heart Rate	Higher	<0.05
Respiratory Rate	Higher	<0.05
Serum Sodium	Higher	<0.05
Serum Creatinine	Higher	<0.05
Serum Bilirubin	Higher	<0.05
Glasgow Coma Scale	Lower	<0.05

Table 8. Significant Predictors of Mortality

Table 8 summarizes all significant predictors of mortality identified in the study. Both APACHE-II and SOFA scores were strongly associated with mortality. Among individual variables, tachycardia, tachypnea, hypernatremia, elevated creatinine, elevated bilirubin, and reduced GCS independently predicted poor outcomes.

DISCUSSION

The present study included 60 patients with sepsis and multi-organ dysfunction syndrome and demonstrated an overall 30-day mortality of 36.7%. This finding is comparable to that reported by Degoricija et al.,[11] who observed a mortality rate of 38.5% among septic ICU patients, and Oliveira et al.,[12] who reported mortality of approximately 35.7% in patients with severe sepsis. The similarity in mortality rates across these studies confirms that sepsis-associated organ dysfunction remains a major contributor to critical care mortality despite improvements in diagnostic and therapeutic modalities.

The mean APACHE II score in survivors in the present study was 16.81 ± 4.52, whereas non-survivors had a significantly higher mean score of 25.63 ± 5.78 ($p<0.05$). Knaus et al.,[4] in the original APACHE II validation study, demonstrated progressively increasing mortality with increasing APACHE II scores, with scores above 25 being associated with substantially higher mortality. Ho et al.[10] reported a mean APACHE II score of 24.8 ± 7.2 among non-survivors compared with 15.7 ± 5.9 among survivors, findings that closely resemble those observed in the present study. These results support the utility of the APACHE II as an effective severity assessment and mortality prediction tool in patients with sepsis and MODS.

The mean SOFA Day-1 score among survivors in the present study was 5.18 ± 1.90 compared with 10.68 ± 1.86 among non-survivors ($p<0.05$). Similarly, the SOFA Day-3 score increased from 5.44 ± 1.99 in survivors to 12.09 ± 1.62 in non-survivors. The mean SOFA score was also significantly higher among non-survivors (11.38 ± 1.66) than survivors (5.63 ± 1.90). Vincent et al., **[5]** in the original SOFA study, reported mortality rates exceeding 80% among patients with SOFA scores greater than 11. Vosylius et al.[13] observed mean SOFA scores of 11.5 among non-survivors and 5.8 among survivors, values remarkably similar to those obtained in the present study. These findings reinforce the strong relationship between the organ dysfunction severity and mortality.

An important observation in the present study was the superiority of serial SOFA assessment over a single admission score. The SOFA score among survivors remained relatively stable between Day 1 (5.18) and Day 3 (5.44), whereas non-survivors showed a progressive increase from 10.68 to 12.09. Similar observations were reported by Abhinandan and Vedavathi,[9] who found that serial SOFA scores showed stronger correlation with mortality than APACHE II scores. Qiao et al[8] reported an area under the ROC curve (AUC) of 0.889 for SOFA compared with 0.826 for APACHE II in predicting mortality among elderly critically ill patients. These findings suggest that dynamic assessment of organ dysfunction provides superior prognostic information compared with a single baseline assessment.[7,8]

The present study demonstrated a significantly higher mean heart rate among non-survivors (124.3 ± 23.2 beats/min) compared with survivors (103.6 ± 22.6 beats/min, $p<0.05$). Similarly, the mean respiratory rate was significantly higher among non-survivors (32.7 ± 7.8 breaths/min) than survivors (23.3 ± 7.5 breaths/min). Oliveira et al.[12] also observed that cardiovascular instability and respiratory dysfunction were more pronounced among non-survivors, emphasizing their importance as indicators of disease severity and poor outcome in septic patients.

Renal dysfunction emerged as a significant determinant of mortality in the present study. The mean serum creatinine level among non-survivors was 2.5 ± 1.21 mg/dL compared with 1.33 ± 0.62 mg/dL among survivors ($p<0.05$). Similar findings were reported by Vincent et al[5] and Vosylius et al.,[13] both of whom demonstrated that worsening renal dysfunction significantly increased mortality risk. Renal impairment remains one of the most important components contributing to both APACHE II and SOFA scores.

Neurological dysfunction also demonstrated a strong association with mortality. The mean Glasgow Coma Scale score among survivors was 12.9 ± 2.0 compared with 9.7 ± 2.3 among non-survivors ($p<0.05$). Bastos et al[6] reported that lower GCS scores were independently associated with increased mortality among critically ill patients and significantly improved the predictive performance of APACHE-based scoring systems. Our findings are therefore consistent with previously published evidence.

The mean serum bilirubin level among non-survivors was 4.02 ± 3.3 mg/dL compared with 1.4 ± 0.54 mg/dL among survivors ($p<0.05$), indicating significant hepatic dysfunction in patients who succumbed to their illness. Similar observations were made by Vincent et al.,[5] who demonstrated that progressive liver dysfunction contributes significantly to increasing SOFA scores and mortality risk.

In contrast, rectal temperature, PaO_2, arterial pH, serum potassium, hematocrit, total leukocyte count, and platelet count did not demonstrate statistically significant associations with mortality in the present study. Ho et al.[10] similarly observed that isolated physiological and laboratory variables had limited predictive value when evaluated independently, whereas composite scoring systems such as APACHE II and SOFA provided superior prognostic accuracy because they incorporated dysfunction across multiple organ systems.

In the current investigation, APACHE II and SOFA scores showed strong correlations with mortality. However, because serial SOFA assessment tracked the development of organ dysfunction over time, it demonstrated superior discriminatory capacity. Vincent et al., Vosylius et al., Qiao et al., and Abhinandan et al. came to similar conclusions, highlighting the importance of sequential organ failure evaluation in predicting outcomes among critically ill patients with sepsis and MODS.[5,8,9,13]

LIMITATIONS

The fact that this study was carried out at a single location with a small sample size is one of its limitations, which could restrict how broadly the results can be applied. Additionally, SOFA Day-3 scores were unavailable for some patients who expired early, potentially introducing bias in serial score assessment. The study did not perform etiology-specific subgroup analyses, and treatment-related variables as well as the severity of the infection source were not evaluated in relation to patient outcomes, which may have influenced the observed mortality predictions.

CONCLUSION

Both APACHE II and SOFA scoring systems demonstrated significant predictive value for 30-day mortality in patients with sepsis and multi-organ dysfunction syndrome, with higher scores being associated with increased mortality risk. Serial assessment of SOFA scores provided superior prognostic information compared to a single measurement, reflecting changes in disease severity over time. Furthermore, there was an independent correlation between mortality and physiological markers such heart rate, respiration rate, serum sodium, serum creatinine, Glasgow Coma Scale score, and serum bilirubin. These results support the routine application of serial SOFA scoring and APACHE II for risk assessment, prognosis, and clinical decision-making in critically sick sepsis patients.

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